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PHOTOMETRIC SEQUENCES AND ASTROMETRIC POSITIONS OF SN 2011fe IN M101 AND SN 2012aw IN M95

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SN 2011fe was discovered in M101 by the Palomar Transient Factory (Nugent et al. 2011a) on Aug. 24 with the Palomar 1.2m Schmidt telescope when the object was at $g = 17.2$ magnitude, and within a few hours from discovery it was classified as a type Ia with the Liverpool Telescope (La Palma, Canary Islands). Comparison with explosion models suggests that SN 2011fe was discovered only about 11 hours after its actual explosion (Nugent et al. 2011b). The supernova peaked at $V \approx 9.9$ mag, making it the fifth-brightest supernova in the past century. A flurry of papers have been already published, mainly triggered by the absence of early radio emission, the lack of an optical counterpart for the progenitor in archival HST images, and negative detection in early X-ray observations. Analysis of archival HST images of the location of SN 2011fe by Li et al. (2011) shows that the luminosity of the progenitor system (especially the companion star) is 10−100 times fainter than previous limits on other type Ia supernova progenitor systems, which rules out luminous red giants and almost all helium stars as the mass-donating companion to the exploding white dwarf, and the Bloom et al. (2012) analysis also rules out main sequence stars. The absence of early radio and X-ray emission, induced by the SN ejecta slamming onto or expanding through pre-existing, slowly moving circumstellar material was used by Horesh et al. (2012) and Chomiuk et al. (2012), to put stringent limits on the density of any circumstellar material, the mass loss rate and therefore on the nature of the SN progenitor.

SN 2012aw was discovered by Paolo Fagotti (Bastia Umbra, Italy) in M95 on CCD images taken on Mar. 16.86 UT with a 0.5-m reflector (cf. CBET 3054). It was classified by Itoh et al. (2012) as a type-IIP supernova from spectra obtained on March 19.5 UT, and confirmed by Siviero et al. (2012) on Asiago spectra obtained on Mar. 17.77 and 19.85 UT as a very young type-II supernova, resembling the type-IIP supernova 1999gi about 4–5 days after the core-collapse.

For both SNe, the amount of published multi-band photometry is minimal with respect to the vast amount being continuously collected world-wide. One possible reason is the absence of accurate local photometric sequences. This IBVS aims to remedy the situation.

In this note we present a $BVR_{\rm C}I_{\rm C}$ photometric sequence around both SNe, optimized for CCD observations and their color corrections. To calibrate the sequences, we obtained CCD photometry with a 0.35-m telescope located at Astrokolkhoz Observatory in Cloudcroft (New Mexico, USA), during a large number of photometric nights, using $BVR_{\rm C}I_{\rm C}$

filters and an SBIG STL-1001E CCD camera. Pixel size is 1.″25/pix and the field of view is 20×20′. Observations on each photometric night included BVR_CI_C exposures of Landolt standard fields (Landolt 1983, 1992) taken at high and low airmasses. The photometric sequences are presented in Figures 1 and 2. Astrometry was performed using SLALIB (Wallace 1994) linear plate transformation routines in conjunction with the UCAC2 reference catalog. Errors in coordinates were less than 0.1 arcsec in both coordinates, referred to the mean coordinate zero point of the reference stars in each field.

The position we derived for SN 2011fe in M101 is: $\alpha_{J2000} = 14^h03^m05^s.711$ (±0.″27), $\delta_{J2000} = +54°16'25.''22$ (±0.″23). The end figures of the supernova position derived by Li et al. (2012) are $05^s.733$ and 25.″18 (J2000.0), who observed with the Near-Infrared Camera 2 (NIRC2) mounted behind the adaptive optics (AO) system on the Keck II telescope. Other positions as appeared on CBET 2792 are: $05^s.81$ and 25.″4 (Palomar 1.2m Schmidt), $05^s.75$ and 25.″2 (R.A. Koff, 0.25m), 05.″74 and 25.″3 (J. Brimacombe, 0.5m), $05^s.74$ and 25.″7 (G. Masi, 0.43m).

Our position for SN 2012aw in M95 is: $\alpha_{J2000} = 10^h43^m53^s.735$ (±0.″091), $\delta_{J2000} = +11°40'17.''63$ (±0.″084). It is within 0.11 arcsec of the unweighted mean of the other determinations of the supernova position so far published. Ending figure given at the time of discovery and summarized in CBET 3054 are: $53^s.76$ and 17.″9 (P. Fagotti, 0.5m), $53^s.78$ and 17.″0 (A. Dimai, 0.28m), $53^s.72$ and 17.″7 (J. Skvarc, 0.6m), $53^s.73$ and 17.″8 (G. Masi, 0.43m); a radio observation by Yadav et al. (2012) provides $53^s.72$ and 17.″5. Positive searches for the progenitor on archival HST images of M95 are mentioned by Elias-Rosa et al. (2012) and Fraser et al. (2012a,b), but no explicit astrometric position is given for the SN.

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SN 2011fe in M101 $\alpha_{\rm J2000} = 14\ 03\ 05.711$ $\delta_{\rm J2000} = +54\ 16\ 25.22$

	α_{J2000} (±")		δ_{J2000} (±")		N	V (±)		B–V (±)		V–$R_{\rm C}$ (±)		$R_{\rm C}$–$I_{\rm C}$ (±)		V–$I_{\rm C}$ (±)	
a	210.957751	0.100	54.151578	0.127	16	11.756	0.005	0.611	0.015	0.318	0.007	0.342	0.005	0.662	0.005
b	211.175550	0.113	54.351805	0.059	16	12.356	0.005	0.744	0.015	0.409	0.004	0.352	0.005	0.760	0.005
c	210.810842	0.060	54.370365	0.059	14	12.927	0.008	0.501	0.014	0.308	0.004	0.294	0.006	0.601	0.005
d	211.018410	0.095	54.225612	0.078	16	13.343	0.006	0.940	0.012	0.510	0.004	0.441	0.004	0.951	0.005
e	211.011509	0.081	54.305018	0.035	15	13.509	0.005	0.617	0.011	0.363	0.003	0.350	0.004	0.713	0.005
f	210.710320	0.054	54.369486	0.065	16	13.646	0.009	0.789	0.015	0.444	0.004	0.402	0.007	0.846	0.007
g	210.806928	0.074	54.262027	0.043	15	13.860	0.010	0.944	0.010	0.556	0.005	0.547	0.004	1.105	0.005
h	210.725528	0.052	54.274797	0.063	13	13.999	0.009	0.618	0.012	0.360	0.003	0.355	0.005	0.715	0.005
i	210.623308	0.080	54.282115	0.084	10	14.150	0.009	0.891	0.013	0.518	0.004	0.432	0.006	0.950	0.007
j	211.067646	0.047	54.428807	0.093	16	14.309	0.005	0.816	0.014	0.464	0.003	0.400	0.007	0.864	0.007
k	210.692101	0.079	54.150685	0.089	13	14.727	0.010	0.583	0.015	0.336	0.005	0.334	0.006	0.670	0.009
l	210.843222	0.090	54.260075	0.045	14	14.827	0.011	1.346	0.017	0.821	0.005	0.751	0.006	1.576	0.005
m	210.898393	0.104	54.341882	0.260	8	15.387	0.047	1.031	0.056	0.572	0.033	0.522	0.012	1.133	0.010
n	210.651256	0.086	54.315059	0.061	11	15.617	0.025	1.310	0.026	0.859	0.011	0.768	0.010	1.630	0.004
p	210.942033	0.160	54.446751	0.236	8	15.694	0.010	0.500	0.012	0.324	0.005	0.303	0.016	0.631	0.016

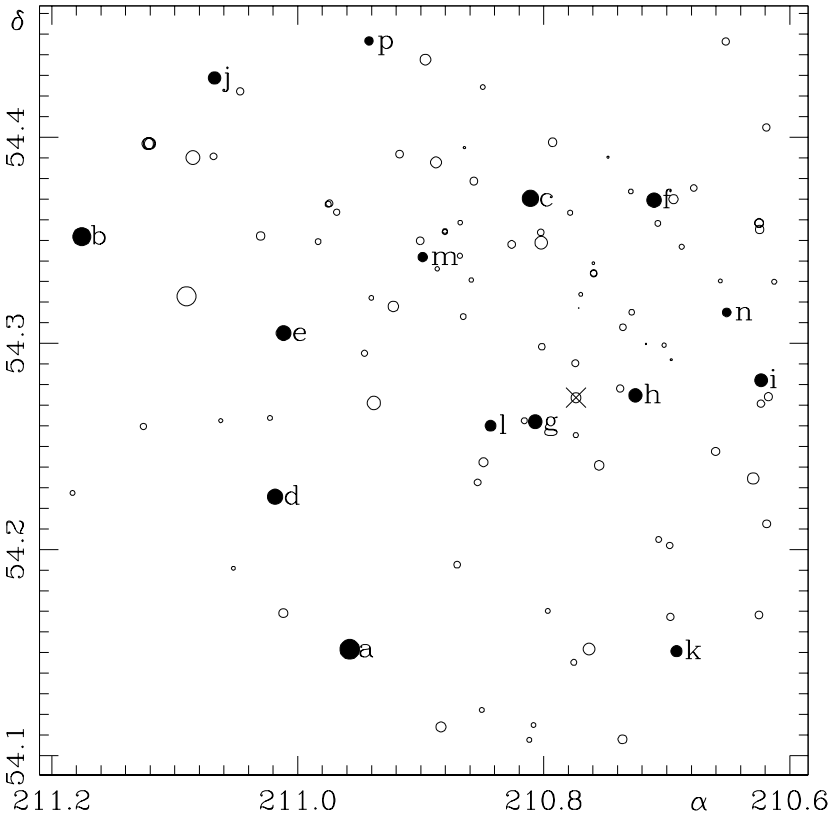

Figure 1. $BVR_{\rm C}I_{\rm C}$ photometric comparison sequence around SN 2011fe in M101. The cross indicates the SN. N is the number of nights in which the given star has been measured, the photometric uncertainties are errors of the mean. The errors in α and δ are expressed in arcsec. The panel covers a $20' \times 6'$ area.

SN 2012aw in M95 $\alpha_{\rm J2000} = 10\ 43\ 53.735$ $\delta_{\rm J2000} = +11\ 40\ 17.63$

	α_{J2000} (±")		δ_{J2000} (±")		N	V (±)		B–V (±)		V–$R_{\rm C}$ (±)		$R_{\rm C}$–$I_{\rm C}$ (±)		V–$I_{\rm C}$ (±)	
a	160.885499	0.075	11.709246	0.032	7	10.329	0.020	0.554	0.020	0.331	0.008	0.363	0.014	0.696	0.016
b	160.878388	0.054	11.830937	0.064	6	11.171	0.011	0.412	0.008	0.259	0.002	0.264	0.007	0.522	0.006
c	160.913578	0.072	11.738825	0.031	4	11.943	0.017	1.033	0.013	0.560	0.007	0.471	0.006	1.035	0.011
d	161.043388	0.114	11.515533	0.094	6	12.082	0.010	0.907	0.008	0.506	0.004	0.430	0.009	0.936	0.010
e	161.096381	0.165	11.712065	0.065	7	12.696	0.007	0.601	0.005	0.347	0.004	0.327	0.005	0.673	0.006
f	160.891623	0.048	11.824786	0.058	6	13.435	0.012	0.650	0.007	0.385	0.002	0.360	0.004	0.745	0.005
g	161.112808	0.168	11.571551	0.167	6	13.487	0.009	0.740	0.007	0.424	0.003	0.370	0.008	0.793	0.008
h	160.879769	0.089	11.504159	0.096	6	13.835	0.007	0.685	0.012	0.418	0.003	0.373	0.007	0.790	0.007
i	160.880875	0.054	11.621125	0.088	7	13.894	0.008	1.085	0.005	0.657	0.005	0.531	0.005	1.187	0.006
j	161.043249	0.132	11.530116	0.097	7	14.440	0.012	0.730	0.007	0.413	0.006	0.356	0.006	0.767	0.003
k	160.910322	0.073	11.583798	0.044	5	14.649	0.008	0.885	0.013	0.503	0.005	0.474	0.005	0.977	0.007
l	160.908136	0.055	11.538903	0.091	7	14.675	0.006	1.215	0.016	0.737	0.014	0.567	0.013	1.303	0.007
m	161.067779	0.241	11.576674	0.123	6	14.839	0.015	0.859	0.020	0.486	0.008	0.408	0.010	0.894	0.003
n	160.936673	0.099	11.684353	0.130	7	14.954	0.010	0.414	0.019	0.256	0.005	0.260	0.010	0.516	0.013

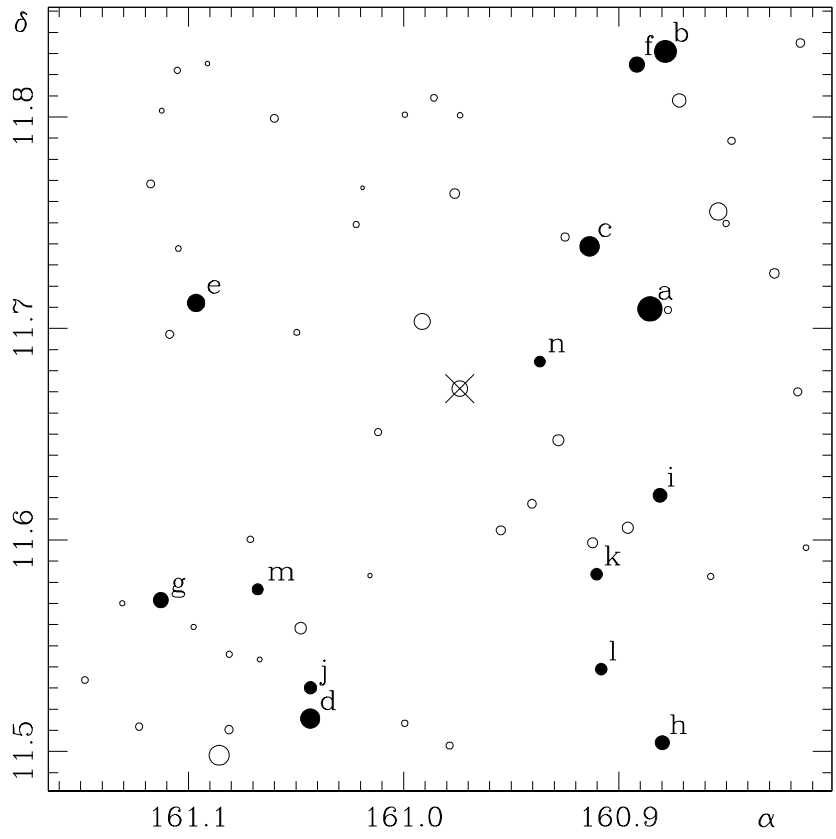

Figure 2. $BVR_{\rm C}I_{\rm C}$ photometric comparison sequence around SN 2012aw in M95. The cross indicates the SN. N is the number of nights in which the given star has been measured, the photometric uncertainties are errors of the mean. The errors in α and δ are expressed in arcsec. The panel covers a $20' \times 20'$ area.